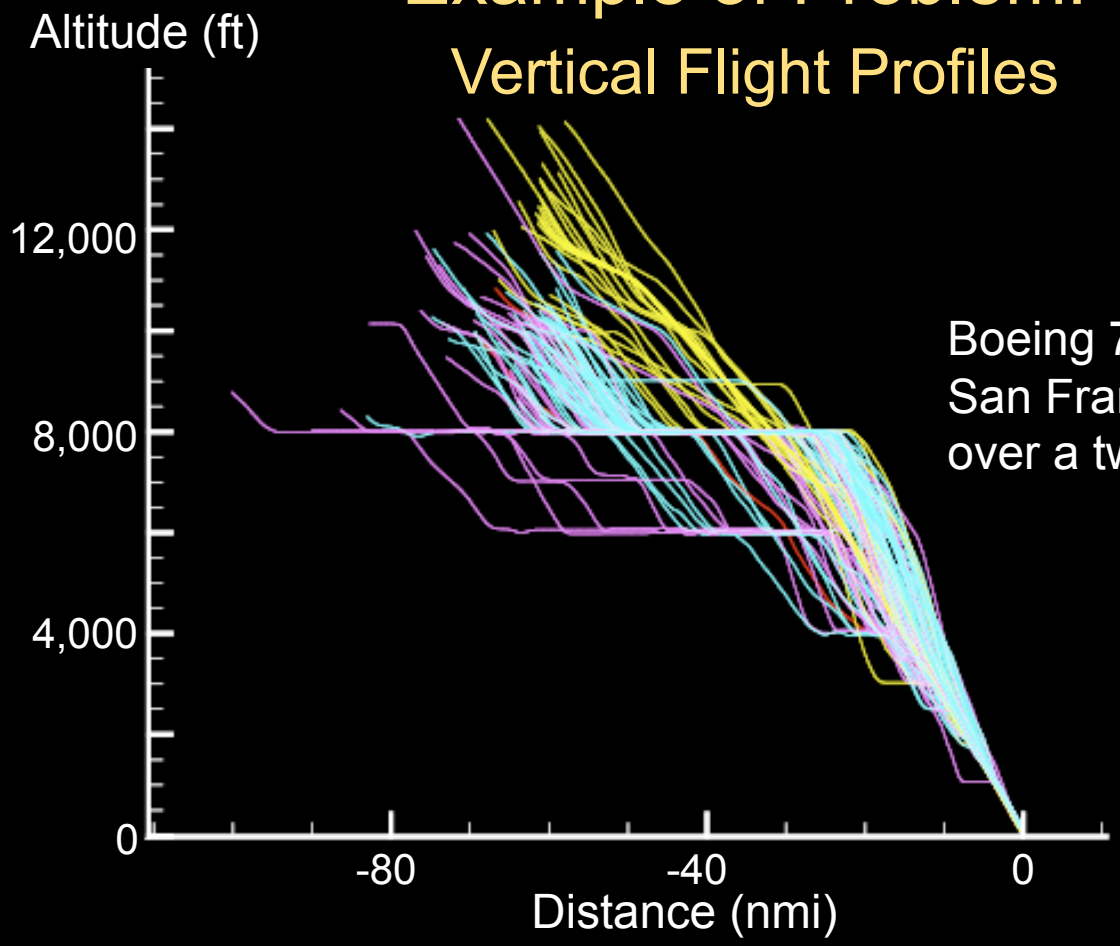
Abstract
Continuous descents at low engine power are desired to reduce fuel consumption, emissions and noise during arrival operations. The challenge is to allow airplanes to fly these types of efficient descents without interruption during busy traffic conditions. During busy conditions today, airplanes are commonly forced to fly inefficient, step-down descents as air-traffic controllers work to ensure separation and maximize throughput. NASA – in collaboration with government and industry partners – is developing new automation to help controllers accommodate continuous descents in the presence of complex traffic and airspace constraints. This automation relies on accurate trajectory predictions to compute strategic maneuver advisories. The talk will describe the concept behind this new automation and provide an overview of the simulations and flight testing used to develop and refine its underlying technology.

Automation for Accommodating Fuel-Efficient Descents in Constrained Airspace

Richard A. Coppenbarger
NASA Ames Research Center

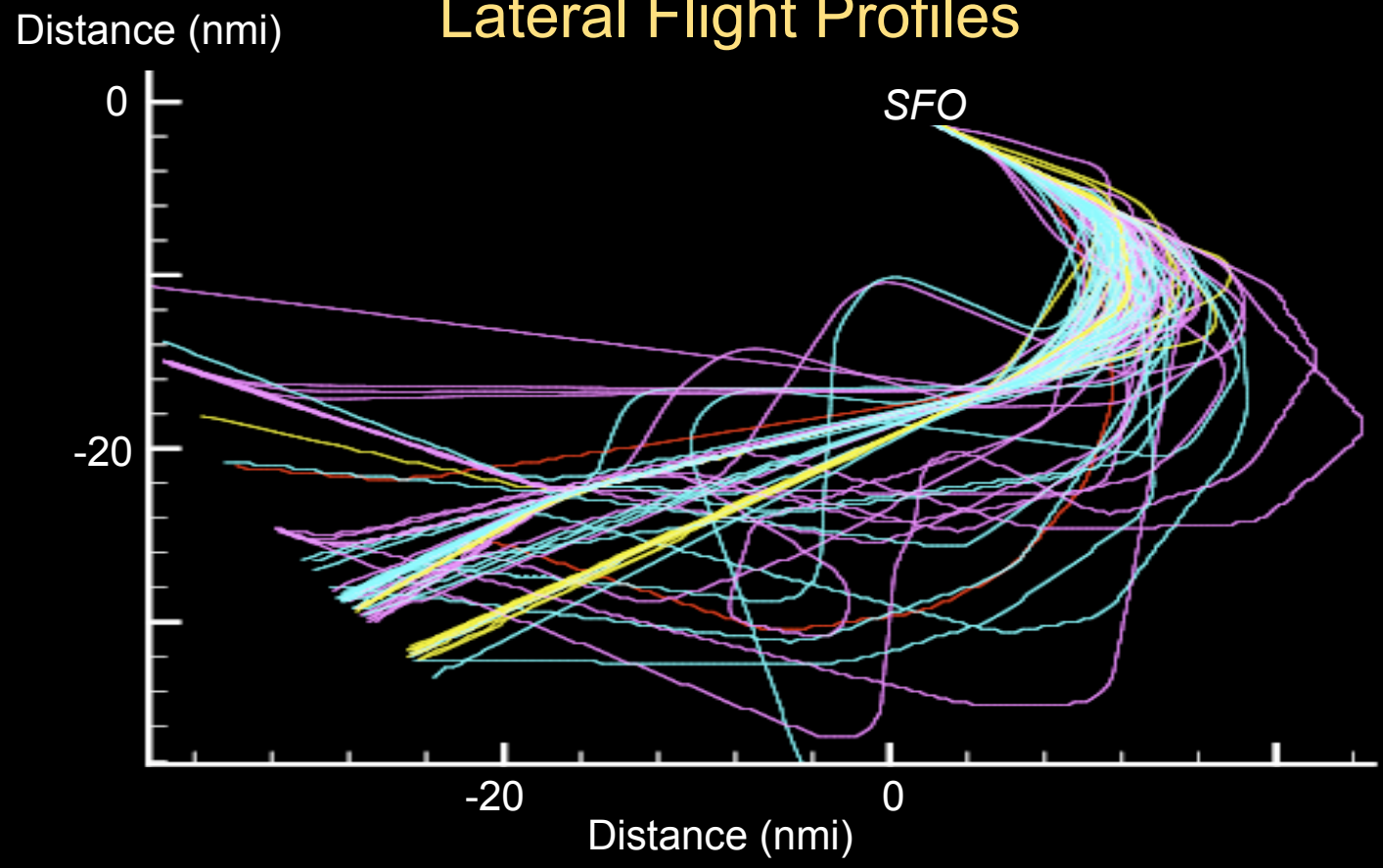
Green Aviation Summit, Sept. 8-9, 2010

Example of Problem:
Vertical Flight Profiles



Boeing 777 arrivals into
San Francisco (SFO)
over a two-week period

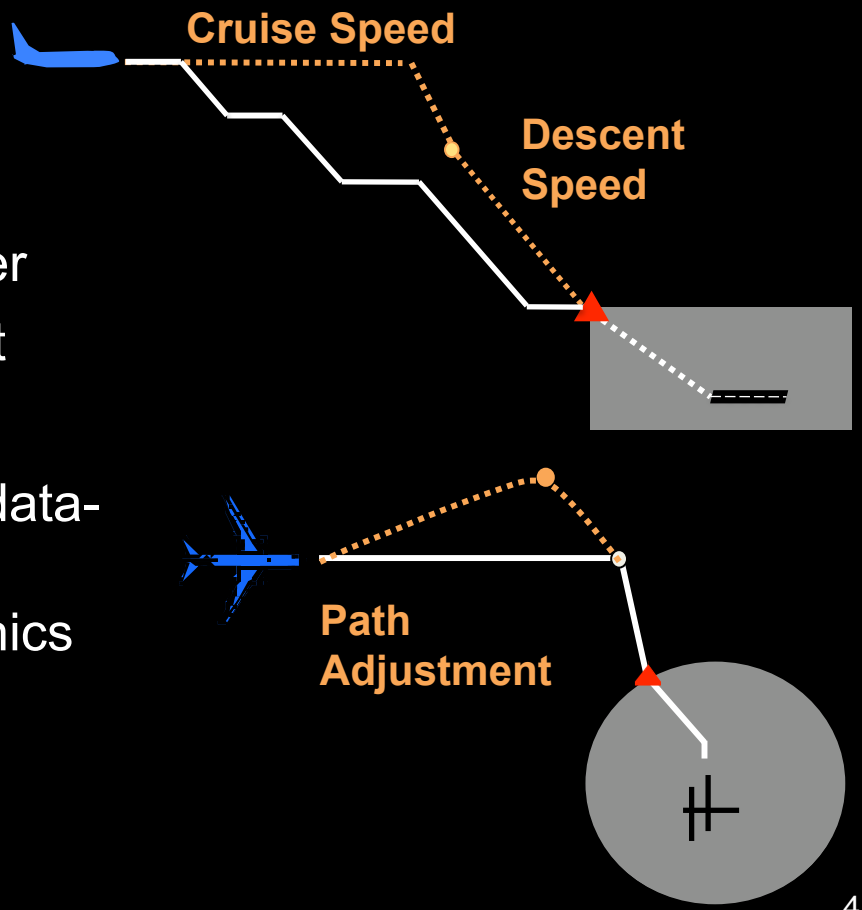
Example of Problem:
Lateral Flight Profiles



Towards a Solution: Efficient Descent Advisor

Trajectory-based, strategic arrival clearances:

- Allow a gliding, continuous descent at low engine power
- Maximize arrival throughput
- Avoid traffic conflicts
- Can be issued by voice or data-link
- Integrate with existing avionics for precision guidance and control



EDA Development

Human-in-the Loop Simulation



Flight Testing



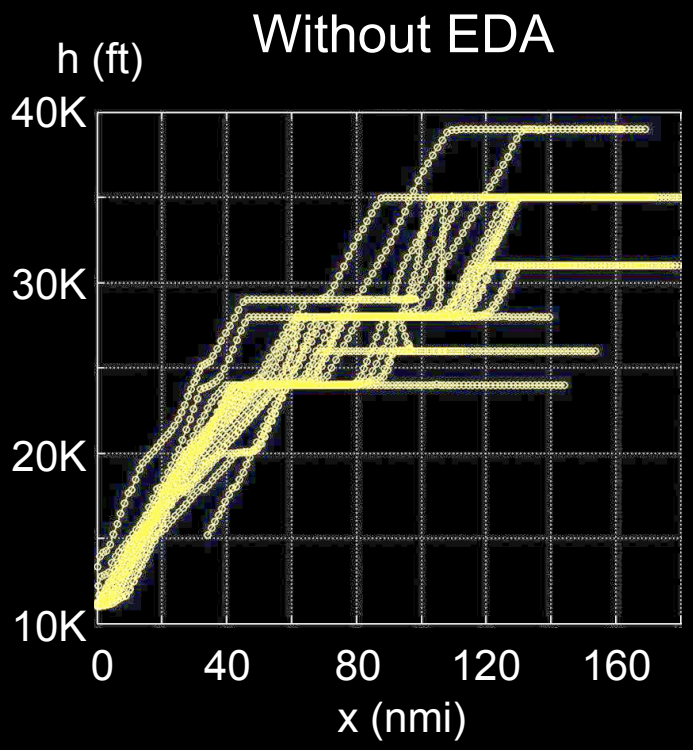
BOEING

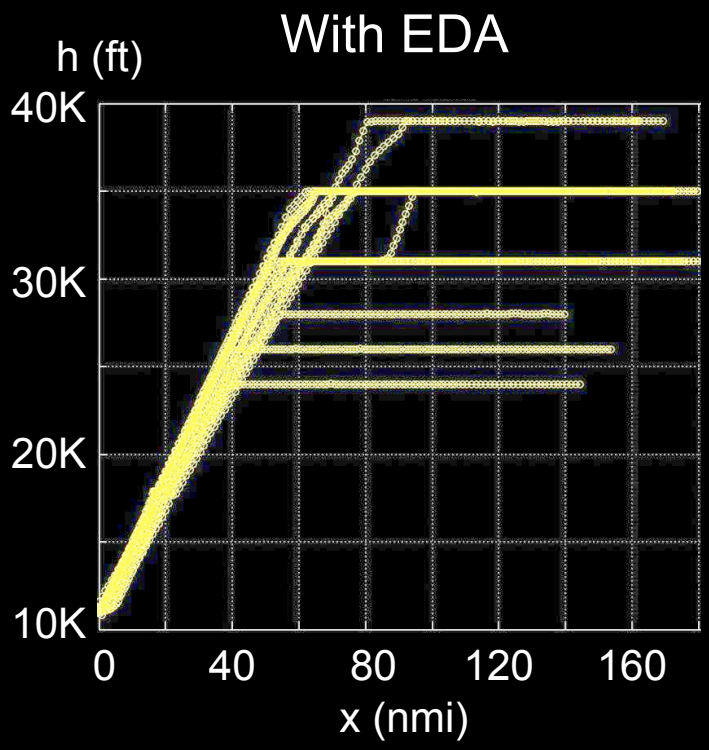
UNITED

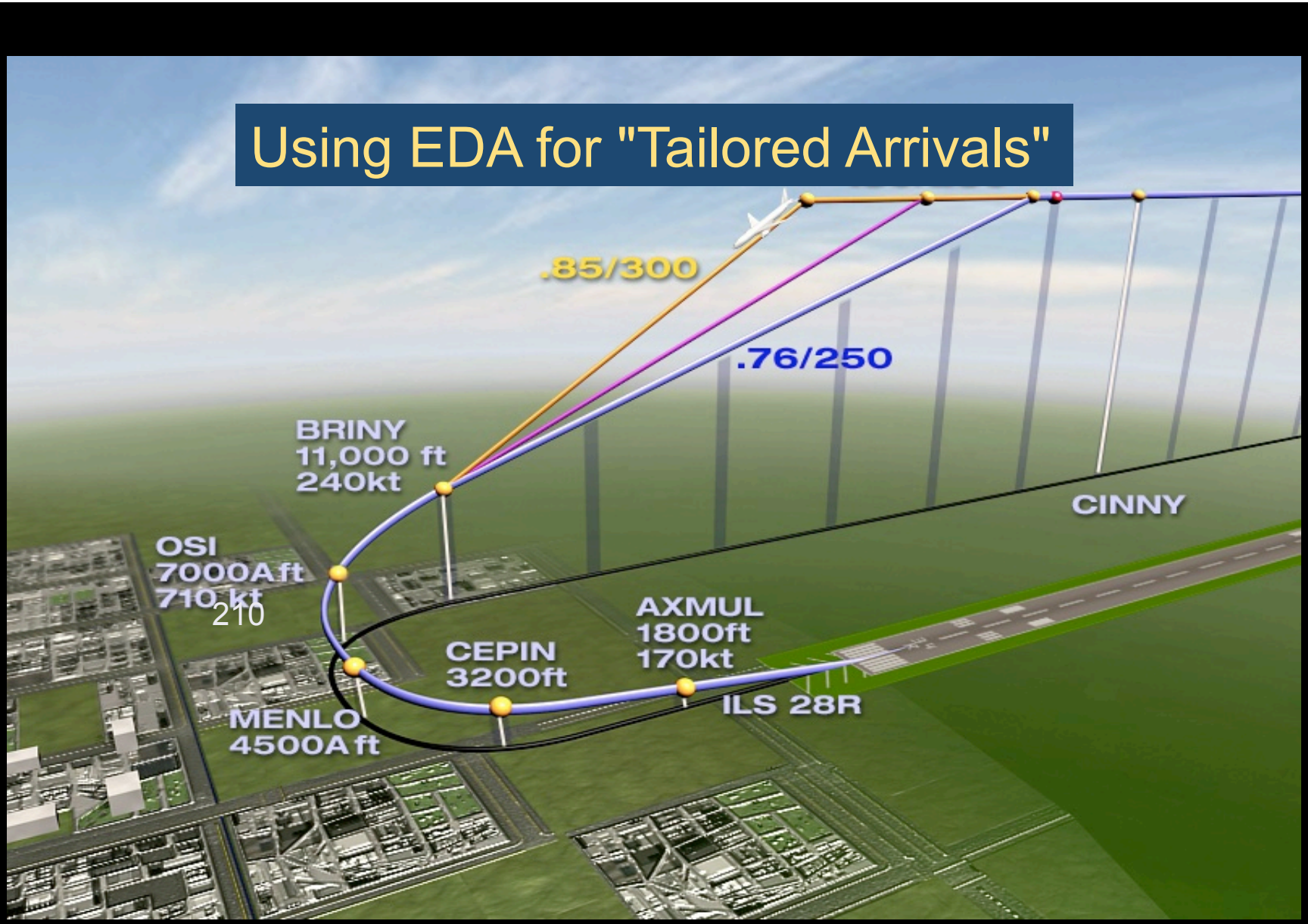
Continental Airlines

Simulation Results

Comparison of Vertical Trajectories






Using EDA for "Tailored Arrivals"
.85/300
.76/250
BRINY
11,000 ft
240kt
CINNY
OSI
7000A ft
710 kt
210
AXMUL
1800ft
170kt
CEPIN
3200ft
ILS 28R
MENLO
4500A ft

Potential Benefits

Fuel and Emissions Reduction from Tailored Arrivals

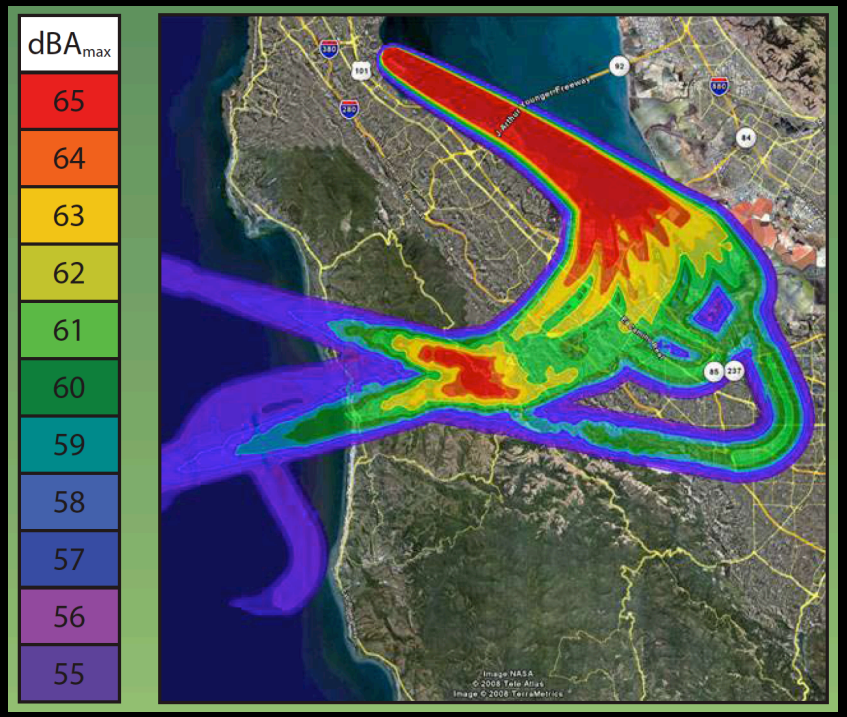
Traffic Conditions	Fuel Savings (lbs)	CO_2 Savings (lbs)
Light	227	715
Med	358	1,128
Heavy	1,760	5,544

For Boeing 777 Operations into San Francisco

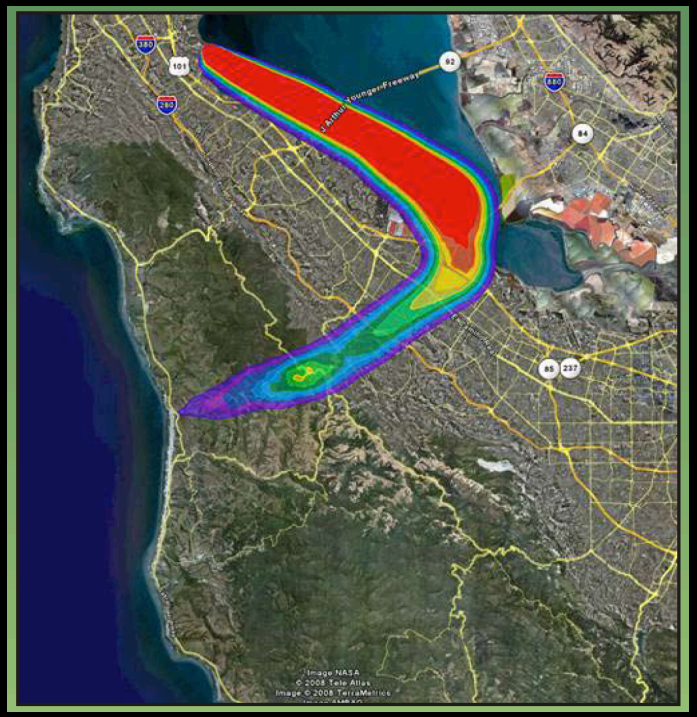
Potential Benefits

Noise Reduction from Tailored Arrivals

Before



After



Summary

- Potential environmental benefits of low-power descents are greatest during busy traffic conditions
- Trajectory-based automation and procedures are key to realizing these benefits
- NASA is working closely with FAA and industry to develop the required technology